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(54) **Automatic voice checklist system for aircraft cockpit**

(57) Automatic voice checklist employing digital speech processing techniques for performing speech synthesis and speech analysis, wherein interactive communication of stored digital information in the form of synthesized speech between the crew of an aircraft and a ground controller is accomplished. An aircraft parameter checklist is stored in digital form in a vocabularly memory for vocal communication to the pilot or crew members of an aircraft upon command. Additionally, transducer monitoring and intelligence may be included in the voice checklist system, wherein certain aircraft parameters are continuously monitored, analyzed and recorded for vocal communication to the pilot or crew member when conditions indicate a possible problem with the performance of the aircraft.



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SPECIFICATION

**Automatic voice checklist system for aircraft cockpit**

This invention generally relates to an automatic synthesized voice checklist system for the cockpit of an aircraft and, in a more particular aspect, to a synthesized voice system for aircraft operation and the monitoring of aircraft performance parameters associated therewith.

Typically, a printed checklist may be provided to the pilot and/or crew members of an aircraft to promote adherence to a routine procedure in checking out various system parameters affecting the performance of the aircraft, such as engine performance, and various operational systems, e.g. electrical, hydraulic, etc. Coupled with this printed checklist as to aircraft system monitoring, the instrument panel of the aircraft is equipped with visual alerting devices in the form of warning lights which will become illuminated when conditions indicate the likely occurrence of an event which may adversely affect the operating performance of the aircraft — e.g. falling oil pressure in any of the aircraft engines.

Additionally, a printed checklist form offering a sequence of procedures to be followed in assessing aircraft performance parameters, such as altitude, cruising speed, rate of climb, etc. may be provided. In the latter connection, certain aircraft operations, such as instrument landings, place a considerable workload on the crew members of the aircraft and air traffic controllers such that often two pilots and checklists are mandatory requirements on some types of complex aircraft. Furthermore, communications between aircraft crew members and air traffic controllers must be lucid and without ambiguity, even though circumstances may impart a hectic character to such communications. To this end, a specialized language has been developed for communications between aircraft crew members and air traffic controllers to promote more efficient communications. Heretofore, efforts to provide communication between aircraft crew members and air traffic controllers have included the use of analog voice tape recorders for a prompting playback of checklist procedure sequences and for in-flight safety of flight recording.

Such aircraft checklist systems and apparatus relating thereto as have been developed to date are of relatively limited scope in that up-dating or in-flight changes in prompting or checklists are difficult to accomplish. Moreover, such aircraft checklist systems and apparatuses offer little real assistence in solving the problems relating to communications between aircraft crew members and air traffic controllers, while further tending to be either unreliable or complex and expensive.

In accordance with the present invention, an automatic synthesized voice prompting system for aircraft operation is provided, wherein synthesized voice instructions are generated to be heard by the aircraft crew members in the form of an audible aircraft operation checklist pertaining to the proper operation of various aircraft system parameters, such as engine(s), operational systems, e.g. electrical, hydraulic, etc. The prompting system includes a vocabulary memory in which is stored a plurality of coded aircraft information alert speech phrases in digital form, a selector panel having appropriate buttons and operably connected to the memory wherein the respective coded aircraft information alert speech phrases may be selected therefrom, speech synthesis electronics operably connected to the memory and responsive to the selection of a coded aircraft information alert speech phrase stored therein, and a speaker connected to the speech synthesis electronics. The speech synthesis electronics may take the form of the speech synthesizing integrated circuits disclosed in pending U.S. Patent application, Serial No. 901,393, filed April 28, 1978 (Case No. TI-7390), wherein audio output signals are generated in response to coded digital signals received as an input for conversion to audible speech by appropriate electronic circuitry and a speaker. In one respect of the present invention utilizing such an automatic synthesized voice prompting system, the pilot or a crew member of an aircraft by pushing an appropriate button on the selector panel causes a checklist sequence as selected by the depression button from the vocabulary memory to be converted by the speech synthesis electronics to an audio output signal which is then reproduced as audible sound via the speaker so as to provide one or more vocal instructions in a predetermined sequence for checking various aircraft system parameters of concern. Such an automatic synthesized voice prompting system for aircraft operation is thereby capable of communicating appropriate checklist instructions to the crew members of the aircraft on command, thus freeing one crew member from the task of reading off a printed checklist. It is further contemplated that the pilot or a crew member could vocally communicate the status of various aircraft system parameters to the system such that inflight/safety flight recording could be performed in a digital format.

In another more sophisticated aspect of the present invention, the automatic synthesized voice prompting system forms a component of an aircraft cockpit synthesized voice system which is also capable of monitoring certain aircraft performance parameters during the operation of the aircraft, such as altitude, cruising speed, rate of climb, etc. In the latter connection, the aircraft cockpit synthesized voice system comprises a plurality of aircraft sensors of analog and digital character in association with a sensor scanner for continuous monitoring of aircraft performance parameters, recordation and analyzation thereof. The sensors and the sensor scanner are operably associated with the voice prompter, and those aircraft performance parameters which may require correction are duly identified by comparison to stored limits in memory for subsequent processing by the speech synthesis electronics so as to be

vocally communicated to the pilot or a crew member via a speaker. It is contemplated that inflight aircraft systems would be monitored by one or more sensors in the same manner such that the detection of a marginal aircraft performance condition would give rise to an appropriate audio/message being communicated to the pilot or crew member via the speaker.

Thus, aircraft checklists relating to aircraft performance parameters would undergo automatic editing via the aircraft cockpit synthesized voice system in accordance with the present invention, thereby relieving the pilot or a crew member from a recurring responsibility to check various aircraft system parameters and aircraft performance parameters during the progress of a flight, beginning with on-ground checking prior to starting the engine(s).

By way of example, and in order to describe various aspects of the invention in greater detail, together with the advantages thereof, reference is made to the drawings, wherein;

Figure 1 is a block diagram of an automatic synthesized voice prompting system for aircraft operation as constructed in accordance with the present invention; and

Figure 2 is a block diagram of an aircraft cockpit synthesized voice system for aircraft operation and the monitoring of aircraft performance parameters associated therewith, as constructed in accordance with the present invention, and including the voice prompting system of Figure 1 as a component thereof.

Referring more particularly to the drawings, Figure 1 illustrates a block diagram of an automatic synthesized voice prompting system for aircraft operation as constructed in accordance with the present invention. The voice prompting system comprises a memory 10 of a non-destructive type and serving as a vocabulary memory in which are stored a plurality of digitally coded aircraft information alert speech phrases. A switch panel 11 is operably connected to the vocabularly memory 10, the switch panel serving as a selector means and including a plurality of switch buttons to enable manual selection of respective coded aircraft information alert speech phrases as stored in the vocabulary memory 10. The operator, who may be the pilot or crew member, selects a particular phrase or phrases to be audibilized from the vocabulary memory 10 by depressing a specific button on the switch panel 11 which produces an input signal along the conductor 12 from the output of the switch panel 11. It will be understood that the conductor 12 and other conductors which are shown in the drawings are representative of appropriate electrical couplings between various components of the systems herein described. In the usual case, the electrical coupling will comprise a plurality of conductors arranged in a bank of conductors or in a bus configuration. Controller means in the form of a microprocessor controller 13 is operably associated with a programmable memory 14. The programmable memory 14 which is of the non-destructive type has an appropriate software control program stored therewithin, the program being responsible for operating the microprocessor controller 13. The microprocessor controller 13 reads the input signal from the switch panel 11 which selects the phrase from the vocabulary memory 10.

The voice prompting system of Figure 1 further includes an address register 15 connected to the input of the vocabulary memory 10 and a command register 16 which is connected to the input of speech synthesis electronics 17. A system clock 18 is provided to synchronize the operation of the various system components in the correct time relationship. To this end, the system clock 18 has a driver line 19 interconnected between the microprocessor controller 13 and the programmable memory 14. The system clock 18 produces clock pulses as an output, the clock pulses being directed along the driver line 19 to synchronize the operation of the microprocessor controller 13, the programmable memory 14, the address register 15 and the command register 16. The address register 15 and the command register 16 are under the direction of the microprocessor controller 13 as instructed by the software program stored in the programmable memory 14. Thus, upon selection of the phrase or phrases from the vocabulary memory 10 by the depression of a particular button on the switch panel 11, the microprocessor controller 13 issues a command to the speech synthesis electronics 17 via the command register 16 and steps through the program stored in the programmable memory 14 generating addresses of data which are input to the vocabulary memory 10 via the address register 15. The vocabulary memory 10 then provides as an output the data corresponding to the selected phrase or phrases by the switch panel selector means 11 or by a continuation of phrases identified by the program stored in the programmable memory 14 to the speech synthesis electronics 17 via a multiplexer 20 which is interposed therebetween. The command register 16 includes a command instruction lead 21 and a clock lead 22 connected to appropriate input terminals of the speech synthesis electronics 17.

Completing the automatic synthesized voice prompting system of Figure 1, sound conversion circuitry is connected to the output of the speech synthesis electronics 17 for receiving the audio output signal therefrom and converting this audio output signal to sound. In this connection, the sound conversion circuitry may include an appropriate low pass filter 23, an audio amplifier 24 and a speaker circuit 25 of a suitable type for converting the audio output from the speech synthesis electronics 17 to sound energy.

It will be understood that the number of phrases which may be vocalized in this manner is limited only by the capacity of the switch panel selector means 11 and the vocabulary memory 10. In its simplest form, the automatic synthesized voice prompting system for aircraft operation may be employed for prompting pilots or crew members in the performance of sequential operation or maintenance on the aircraft via an audibilized checklist. It is contemplated that the switch panel 11 would be installed in the aircraft cockpit and would include a plurality of buttons for operating respective mode switches to select any of the standard checklists, heretofore pro-

vided by printed forms, such as starting the engine(s) of the aircraft, before take-off, after take-off, before landing, etc. The voice prompting system of Figure 1 may be so arranged as to either step through a particular checklist automatically by issuing voice instructions to the pilot or a crew member on a timed interval, or may be so constructed as to issue a voice instruction for a first item in an instruction sequence and then inhibit further operation until the operator (the pilot or a crew member) signified that the next item in the checklist sequence is desired or a repeat of the last item is desired by depressing an appropriate push-button or actuating a suitable control means. It is further contemplated that the automatic synthesized voice prompting system may comprise a permanent installation in the aircraft or could be a portable system. The programmable memory 14 may be of a plug-in memory module type, wherein solid-state software memory modules may be interchanged in the system as desired so as to alter the operation of the system depending upon which type of aircraft is being utilized in conjunction with the voice prompting system. This approach as adopted with a portable system would substantially increase the versatility of the system. However, even where the voice prompting system is of the permanently mounted type, a personalized checklist for the aircraft could be provided by the use of plug-in solid-state software memory modules in the programmable memory 14 offering a variety of software programs under which the voice prompting system may be operated.

It will be further understood that upon completion of a specific checklist sequence as selected by the depression of a particular button on the switch panel 11, or if desired to abort a specifically selected phrase or phrases, a reset signal is communicated from the switch panel 11 to the microprocessor controller 13 via a reset line 26. The microprocessor controller 13 is then conditioned to accept another instruction signal from the switch panel 11 which selects a new phrase from the vocabulary memory 10 in response to the depression of another button, whereupon the microprocessor controller 13 operates in the previously-described manner stepping through the program stored in the programmable memory 14 to enable new addresses of data to be generated for input to the vocabulary memory 10 via the address register 15. The reset circuitry associated with the switch panel 11 may be so constructed as to enable the automatic generation of a reset signal via the programmable memory 14 to the microprocessor controller 13 upon completion of the checklist sequence corresponding to the particular button depressed on the switch panel 11. Alternatively, the switch panel 11 may be equipped with a special reset button for manual depression by an operator in order to transmit a reset signal to the microprocessor controller 13 via the line 26 should it be desired to abort a specifically selected phrase or phrases.

By way of example, the voice prompting system of Figure 1 employs a linear predictive coding technique in the speech synthesis electronics 17 which preferably includes a speech synthesis chip, such as the TMC 0280 speech synthesis chip manufactured by Texas Instruments Incorporated, Dallas, Texas. This chip operates from sequentially called single frames of digitally stored speech intelligence and is of a type disclosed in the aforesaid pending U.S. patent application Serial No. 901,393, filed April 28, 1978 (Case No. TI-7390). This particular speech synthesis technique utilizes an electronically alterable model of the human vocal track which is configured by digital input. Along with the digital configuration input, pitch and other excitation digital control signals are applied to generate an analog signal representing the audio sound requested and identified by the digital information input to the speech synthesis chip 17. Other suitable forms of speech synthesis devices may also be employed in the voice prompting system in accordance with this invention. Previously digitally coded speech is stored in the vocabulary memory 10 and applied to the speech synthesis chip 17 as required by the selected button on the switch panel 11 and controlled by the microprocessor controller 13. A model of the voice prompting system was constructed in which a plurality of TMS-2716 storage circuits as manufactured by Texas Instruments Incorporated comprised the vocabulary memory 10 and were used for the storage of a plurality of sample aircraft information alert speech phrases as listed in Table 1.

| *Phrase No.* | *Phrase* | *8 Bit Bytes of Storage Required* |
|---|---|---|
| 1 | Unknown Aircraft Threat | 142 |
| 2 | SAM Launch | 204 |
| 3 | Bogie 10 O'clock Five Miles | 388 |
| 4 | Missile System Armed | 262 |
| 5 | Increase Display Scale | 263 |
| 6 | Warning Buzzer (Sound Effect) | 263 |
| 7 | Hydraulic Boost Failure | 285 |
| 8 | IR Cool Down | 288 |
| 9 | Landing Gear Down and Locked | 334 |
| 10 | Flaps At 30 Degrees | 308 |
| 11 | Carburetor Inlet Freezing | 313 |
| 12 | Altitude Low Pull Up | 284 |
| 13 | Traffic 10 O'clock Two Miles | 343 |
| 14 | Warning Buzzer (Sound Effect) | 263 |
| 15 | Set Directional Gyro | 322 |
| 16 | Oil Pressure Low | 227 |

Each of the 16 listed phrases corresponds to an individual switch setting on the switch panel 11 as activated by respective buttons, for example. Upon depression of a specific button on the switch panel 11, the input signal produced thereby is referenced to one of the 16 phrases shown in Table 1. In the model as constructed, the microprocessor controller 13 was an 8080 microprocessor as manufactured by Texas Instruments Incorporated, while the programmable memory 14 operably associated therewith was a plurality of TMS 2708 circuits as manufactured by Texas Instruments Incorporated in which a software control program was stored, the software control program being shown in Table 2.

*TABLE 2*

*IMC0281 CONTROL PROGRAM*

```
0000 3E ØØ      PWRUP:  MVI A, Ø          ;  280 Reset Instruction
0002 32 ØØ AØ           STA ØAØØØH        ;  Store in TMC0280
0005 F6/8Ø              ORI 8ØH           ;  Command Register
0007 32ØØ AØ            STA ØAØØØH        ;  Pulse PDC
000A E6 7F              ANI 7FH
000C 32 ØØ AØ           STA ØAØØØH
000f 3A ØØBØ    START:  LDA ØBØØH         ;  Read Switch Register
0012 E6ØF               ANI ØFH
0014 87                 ADD A             ;  Left Shift to Get
                                          ;  Pointer Offset
0015 Ø6 4Ø              MVI B, 404        ;  Load BC with Phrase
0017 4F/                MOV C, A          ;  Pointer + Offset
0018 ØA                 LDAX B            ;  Load LSB of Phrase
                                          ;  Address and Store
0019 32 ØØ 8Ø           STA 8ØØØH         ;  in AREGO
001C ØC                 INR C             ;  Point to next bite
                                          ;  of address
001D ØA/                LDAX B            ;  Load MSB of Phrase
001E 32 ØØ 9Ø           STA 9ØØØH         ;  Address & Store in ARPG
0021 3EØH               MVI A, ØAH        ;  280 Speak Inst.
0023 32/ØØ AØ           STA ØØAØØØH       ;  Store in TMC0280
                                              Comm. Reg
0026 F68Ø               ORI 8ØH           ;  Pulse PDC
0028 32ØØ AØ            STA ØAØØØH
002B E6 7F              ANI 7FH
002D 32 ØØ AØ           STA ØAØØØH
0030 Ø1 ØØ ØØ           LXI B, Ø          ;  Setup Delay Count
0033 3E ØA              MVI A, ØAH
0035 ØC          L1:    INR C             ;  Delay Between Phrases
0036 C2 35 ØØ           JNZ L1            ;  (5 Sec.)
0039 Ø4                 INR B
003A C2 35 ØØ           JNZ L1
003D 3D                 DCR A
003E C2 35 ØØ           JNZ L1
0041 C3 ØF ØØ           JMP START
```

$$.5 \times N\,(256((15.256) + 15) + 15) = 5 \text{ sec}$$

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When operating from the specific model software control program of Table 2, the TMS 8080 microprocessor controller 13 reads the input signal from the switch panel 11 which selects one of the 16 phrases listed in Table 1 from the TMS 2716 storage circuits comprising the vocabulary memory 10. The TMS 8080 microprocessor controller 13 then commands the TMC 0280 speech synthesis chip via the command register 16, stepping through the program shown in Table 2, thereby generating data representing a frame of speech at a time which is input to the TMC 0280 speech synthesis chip of the speech synthesis electronics 17 via the vocabulary memory 10 and the multiplexer 20. The TMC 0280 speech synthesis chip on command generates an audio signal output which is then transmitted through sound conversion circuitry to convert the audio signal output to sound energy in the form of audible instructions, commands, or alert statements corresponding to the selected phrase from Table 1 to prompt the pilot(s) or crew members in the performance of sequential operation or maintenance on the aircraft or to alert the aircraft personnel to potentially dangerous conditions.

The program listed in Table 2 may be stepped through in each operating sequence of the voice prompting system of Figure 1 in the following manner. In the specific model, the program is structured to reset automatically on power up. Then, the program reads the switch settings as selected on the switch panel 11 and obtains a specific speech frame of digital information from the vocabulary memory

10 for presentation to the speech synthesis electronics 17. The program then issues a speak command and continues on to the next speech frame of digital information. Upon completion of the required set of speech frames that make up a phrase by stepping through the same program operating sequence as necessary, the microprocessor controller 13 recognizes an "end of phrase" signal identified by the program and resets to await the next input signal transmitted along the conductor 12 as selected from the switch panel 11. Additionally, the model voice prompting system incorporated a timing loop in the program to automatically repeat the last phrase every 5 seconds if a new phrase had not been selected from the switch panel 11.

Referring now to Figure 2, an aircraft cockpit synthesized voice system is depicted therein in block diagram form, the aircraft cockpit synthesized voice system being adapted to be fully integrated with a particular aircraft. The aircraft cockpit synthesized voice system includes as a component thereof the voice prompting system of Figure 1 as modified to accommodate aircraft performance monitoring means as will be described hereinafter. In the more sophisticated system of Figure 2, the voice prompting system component thereof is shown within dashed lines and corresponds to the voice prompting system of Figure 1, except that the switch panel 11 of the voice prompting system illustrated in Figure 1 has been replaced by conductive leads from the aircraft radio, the pilot, and scanning means associated with the monitoring devices for providing information relating to aircraft performance parameters. To this end, the individual components of the voice prompting system included in the aircraft cockpit synthesized voice system of Figure 2 have been identified by the same reference numerals employed in Figure 1 with the prime notation added. Except as hereinafter described, it will be understood that these components operate in the same manner as in Figure 1. In this instance, for example, the microprocessor controller 13' may take the form of a TMS 9980 microprocessor as manufactured by Texas Instruments Incorporated.

The aircraft performance parameter monitoring means of the system of Figure 2 comprises a plurality of aircraft sensors of analog and digital character in association with respective scanner interface circuits, shown as an analog sensor interface circuit 30, a digital interface sensor circuit 31, and a digital bus interface circuit 32, it being understood that a plurality of aircraft sensors of differing analog and digital types are placed at various locations on the aircraft for gathering aircraft performance data. The outputs from these respective aircraft sensors are selectively received by the analog sensor interface circuit 30 and the digital sensor interface circuit 31 in association with the digital bus interface means 32 for sequential transmission to a scanning means 33 which may comprise a TMS 9901 sensor scanning circuit as manufactured by Texas Instruments Incorporated, the latter sensor scanning circuit 33 being adaptable for interfacing with the TMS 9980 microprocessor controller 13' of the voice prompting system via a lead 12'. Suitable analog and digital interface circuits may be employed as the analog sensor interface circuit 30, the digital sensor interface circuit 31 and the digital bus interface circuit 32. The sensor scanning circuit 33 periodically traverses the respective inputs thereto from the analog sensor interface circuit 30, the digital sensor interface circuit 31 and the digital bus interface circuit 32 in a continuous scanning sequence for receiving current data from each of the analog and digital aircraft sensors as they provide such data to the bank of interface circuits 30, 31 and 32. By providing an appropriate program in the programmable memory 14' for use with the sensor scanning circuit 33 which is interconnected therewith and with the microprocessor controller 13', the aircraft cockpit synthesized voice system of Figure 2 is effective to monitor aircraft performance parameters during the operation of the aircraft, such as altitude, cruising speed, rate of climb, etc. In the latter connection, by way of example, the phrase meaning designated by phrase numbers 3, 10 and 13 from Table 1 may be altered in the word and numerial composition thereof to automatically reflect the correct current numerical values based upon input data received by the sensor scanning circuit 33. The system may detect if a particular item of a checklist sequence is set in the appropriate position for normal operation of the aircraft. If normal operation is indicated, the microprocessor controller 13' eliminates that particular item from the checklist sequence, since voice prompting by enabling the speech synthesis electronics 17' to audibilize instructions to the pilot or crew members is unnecessary under such circumstances.

The aircraft instrument panel or auxiliary mode controls or displays in the aircraft may be operably connected to the microprocessor controller 13' to provide inputs thereto, this signal input being diagrammatically indicated by the input lead 40. Additionally, a radio link to the microprocessor controller 13' is indicated by the input lead 41. It will be understood that the mode controls available to the pilot or crew members may include a switch panel keyboard similar to the switch panel 11 of Figure 1 so that the pilot or crew members may manually initiate a desired checklist sequence via the input lead 40 to the microprocessor controller 13' for receiving voice communication from the voice prompting system via the speech synthesis electronics 17' which may be in the form of operation or maintenance instructions and the like as accomplished with the voice prompting system of Figure 1.

Additionally, the leads 40 and 41 may be input/output leads for intercommunication between the voice prompting system and any crew member or radio link in the operation of the aircraft cockpit synthesized voice system of Figure 2. In this respect, the displays on the aircraft instrument panel or on auxiliary devices viewable by the pilot or crew members may be of visible and/or audible types so as to serve as a further alert feature advising or warning the pilot and crew members of potential improper aircraft performance conditions. The two-way radio link communicating with the voice prompting system via the input/output lead 41 may be employed as a remote control actuator to trans-

mit the selected aircraft information alert speech phrase, such as from the list given in Table 1, to the voice prompting system. It is contemplated that a standard Com/Nav aircraft radio or other suitable radio or data link may be employed for this purpose which permits remote control operation of the system shown in Figure 2. Thus, transmission of information to and from the aircraft could be remotely accomplished in this manner by employing only the numbers assigned to particular phrases indicative of a selected checklist sequence instead of the full text of the checklist to provide a substantial enhancement in the capacity of the channel 41 for information flow.

In accordance with the present invention, the voice prompting system of Figure 1 and the aircraft cockpit synthesized voice system of Figure 2 as employed in aircraft operations are effective to: (1) relieve the pilot(s) and crew members of keeping up with and reading checklists; (2) automatically edit checklists for aircraft performance parameters in the correct position and only vocally inform the pilot(s) and crew members of those aircraft performance parameters that may need changing for the current aircraft operation; (3) relieve the pilot(s) and crew members of monitoring aircraft performance parameters by having the parameters read and converted digitally to a voice message communicated to the pilot(s) and crew members; (4) advise the pilot(s) and crew members of out-of-tolerance conditions with appropriate warning messages; and (5) reduce the interplay of communications between the aircraft and ground personnel by enabling only message identifiers to be transmitted therebetween instead of the full message text.

Although the present invention has been described in relation to a specific embodiment thereof, it will be apparent to those skilled in the art that various modifications may be made without departing from the spirit or scope of the present invention.

CLAIMS

1. An automatic synthesized voice prompting system for aircraft operation comprising:

memory means having a plurality of coded aircraft information alert speech phrases stored therein;

selector means operably connected to said memory means for selecting the respective coded aircraft information alert speech phrases from said memory means;

speech synthesis means operably connected to said memory means and responsive to the selection of a coded aircraft information alert speech phrase stored in said memory means for generating an audio output; and

speaker means connected to said speech synthesis means for receiving the audio output therefrom and providing the selected coded aircraft information alert speech phrase as audible sound.

2. A voice prompting system for aircraft operation as set forth in Claim 1, further including

controller means operably interposed between said selector means and said speech synthesis means for receiving an input from said selector means indicative of the selected aircraft information alert speech phrase; and

command register means operably connected to the output of said controller means and to the input of said speech synthesis means and responsive to said controller means for directing said speech synthesis means to accept data from said memory means and to generate said audio output representative thereof.

3. A voice prompting system for aircraft operation as set forth in Claim 2, wherein said controller means comprises a microprocessor controller and a programmable memory interconnected therewith for instructing said microprocessor controller in its operating sequence, said microprocessor controller being connected to said selector means for receiving an input therefrom indicative of the selected aircraft information alert speech phrase and providing an output conditioned by the instructions from said programmable memory to said command register means for activation thereof.

4. A voice prompting system for aircraft operation as set forth in Claim 2, further including

address register means operably interposed between said controller means and said memory means for receiving an input from said controller means for generating addresses of data corresponding to the selected aircraft information alert speech phrase; and

said memory means being connected to the output of said address register means for accepting the data addresses generated thereby to identify the selected coded aircraft information alert speech phrase stored therein for transmission as an output to said speech synthesis means.

5. An aircraft cockpit synthesized voice system for aircraft operation and the monitoring of aircraft performance parameters associated therewith, said aircraft cockpit synthesized voice system including

plural sensor means adapted to being disposed in various locations on the aircraft for monitoring performance conditions and providing data indicative thereof;

sensor scanning means operably associated with said plural sensor means for periodic reception of aircraft performance data therefrom;

memory means operably connected to said sensor scanning means for receiving as an input therefrom collected data from said plural sensor means, said memory means having a plurality of coded aircraft information alert speech phrases stored therein and being responsive to the sensor data for identifying coded aircraft information alert speech phrases stored therein;

speech synthesis means operably connected to said memory means and responsive to coded aircraft information alert speech phrases as output therefrom in response to the received sensor data for generating an audio output; and

speaker means connected to said speech synthesis means for receiving the audio output therefrom and providing a vocal message corresponding to the coded aircraft information alert speech phrase provided by said memory means to said speech synthesis means.

6. An aircraft cockpit synthesized voice system

for aircraft operation as set forth in Claim 5, wherein said plural sensor means includes both analog and digital sensors.

7. An aircraft cockpit synthesized voice system for aircraft operation as set forth in Claim 6, further including

interface circuit means interposed between said analog and digital sensors and said sensor scanning means for transmitting as inputs to said sensor scanning means in a continuing periodic sequence aircraft performance data as detected by said sensors.

8. An aircraft cockpit synthesized voice system for aircraft operation as set forth in Claim 5, further including

controller means operably interposed between said sensor scanning means and said speech synthesis means for receiving inputs from said sensor scanning means corresponding to aircraft performance data as detected by said plural sensor means; and

command register means operably connected to the output of said controller means and to the input of said speech synthesis means and responsive to said controller means for directing said speech synthesis means to accept data from said memory means and to generate said audio output representative thereof.

9. An aircraft cockpit synthesized voice system for aircraft operation as set forth in Claim 8, further including

mode control means adapted to be positioned within the aircraft and intercommunicatively connected to said controller means to enable initiation of a selected aircraft checklist maintenance sequence by providing an input to said controller means indicative thereof.

10. An aircraft cockpit synthesized voice system for aircraft operation as set forth in Claim 8, further including

remote control means intercommunicatively connected with said controller means for transmitting thereto data representative of a selected aircraft information alert speech phrase.

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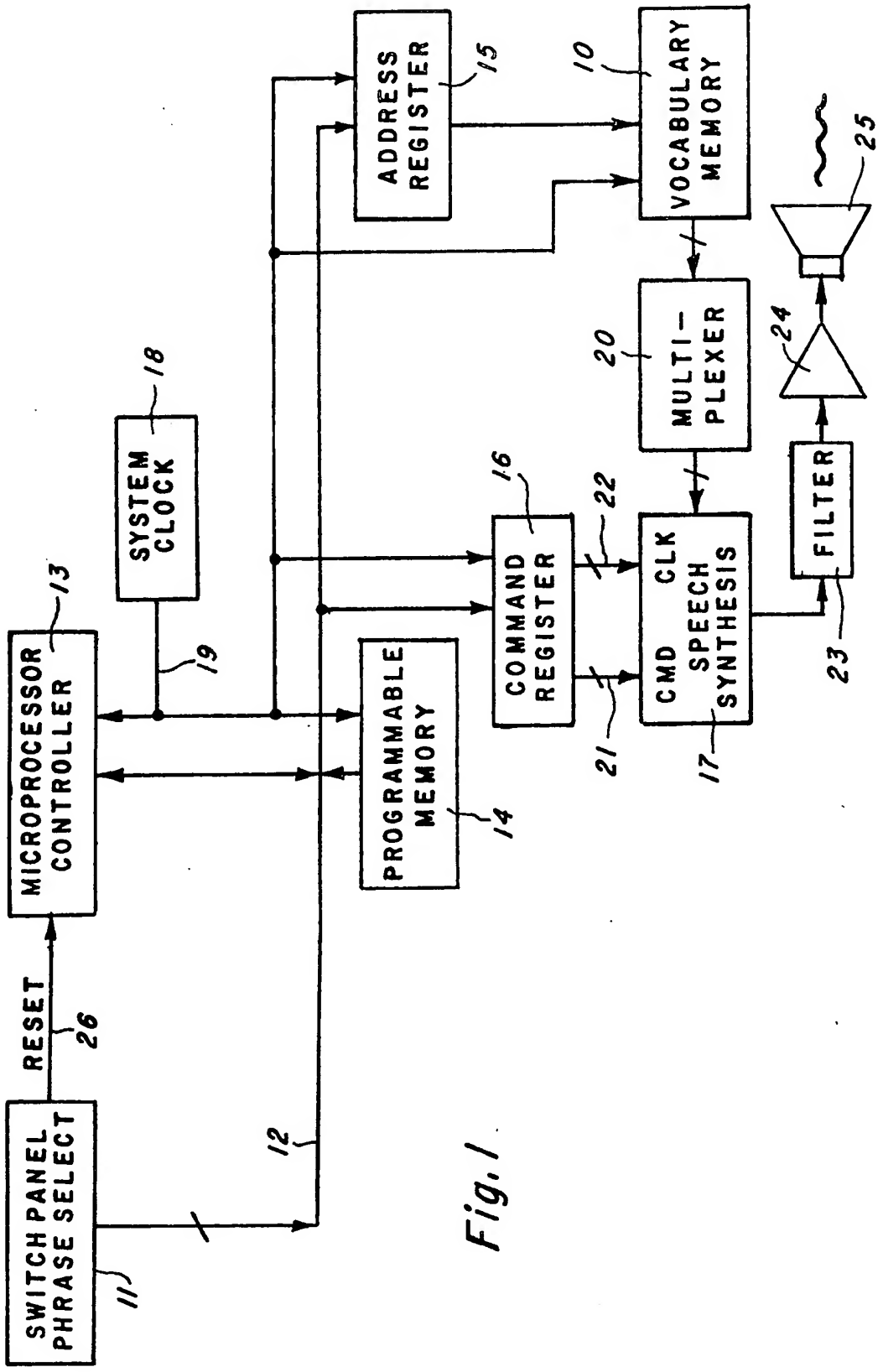
SWITCH PANEL PHRASE SELECT
11
RESET
26
MICROPROCESSOR CONTROLLER
13
SYSTEM CLOCK
18
19
12
PROGRAMMABLE MEMORY
14
ADDRESS REGISTER
15
COMMAND REGISTER
16
22
21
CMD CLK SPEECH SYNTHESIS
17
VOCABULARY MEMORY
10
MULTI-PLEXER
20
FILTER
23
24
25

Fig. 1

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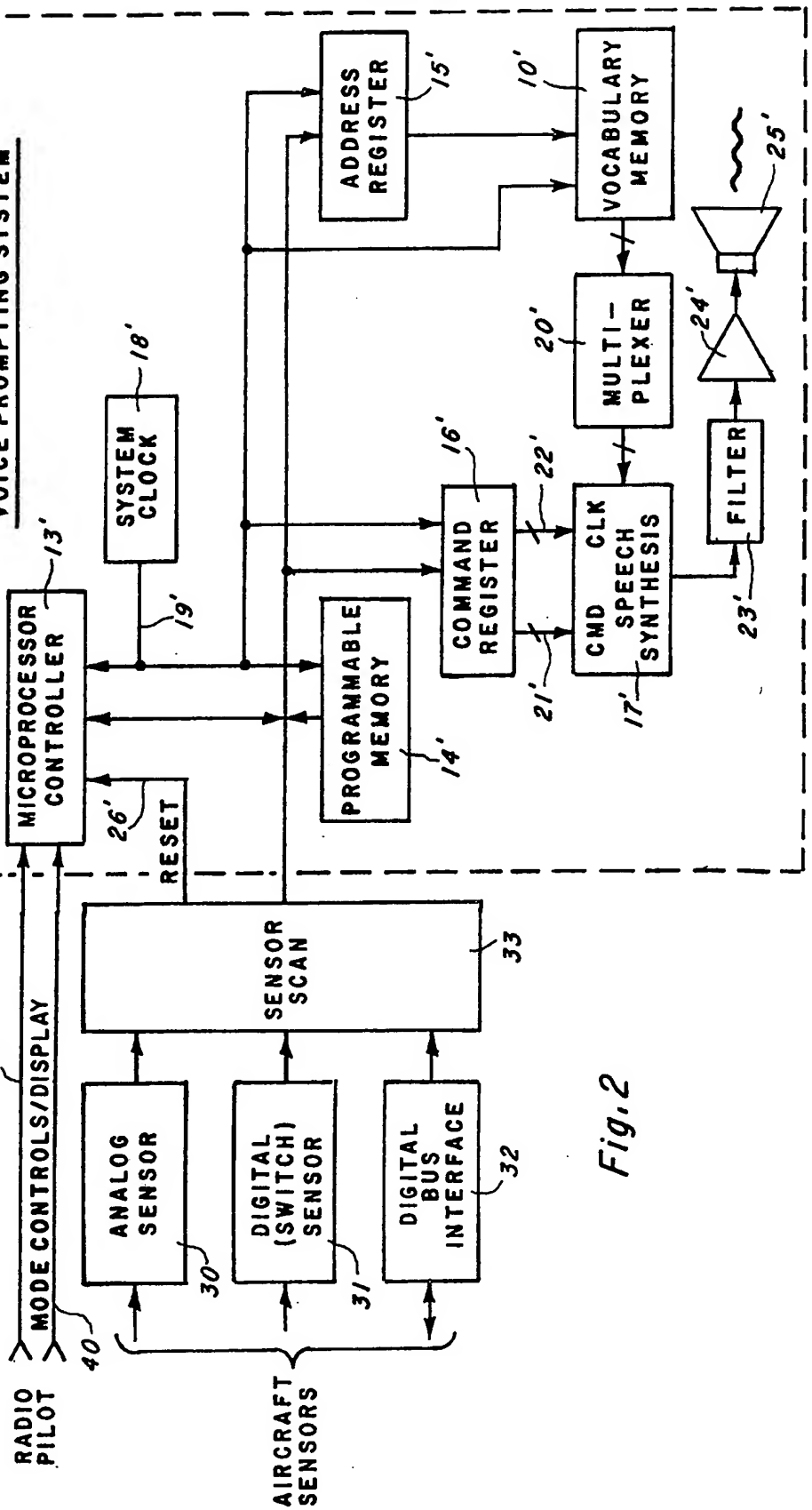


Fig. 2